## THE HASKIN LETTER

## Lighting Industrial Plants

By Frederic J. Haskin.

According to careful estimates, based upon reports of inspectors of insurance and liability companies for the year 1914, fully one-fourth of the accidents occurring in industrial plants, mines and railroad yards were due to defective lighting. Since the annual cost of industrial accidents approximates $300,000,000 financial loss, aside from the lives and crippled bodies of the men and women suffering by them, the need of greater care in this direction becomes apparent. Workmen are asking for better light for their own physical safety. Employers are anxious to give it because even those who are callous to the interest of their workers wish to avoid unnecessary financial loss to themselves. Those interested in welfare work are urging definite lighting regulations as essential to the safety of humanity.

Insurance companies are making careful studies of the lighting conditions of a plant before issuing insurance to its owners or to the workmen employed there. Even safety devices placed around dangerous machinery fail to give full protection if the machines themselves are located in a dim light, or are under a glare which affects the eyes of the worker and hinders him from noting the safety wranings.

The factory laws in several states require that each factory be "properly and suitabl ylighted," but the ful requirements of these terms are not yet understood by the state, the employers or the workers. The study of industrial lighting in this country is yet in its infancy. It has received more attention in Europe, which is one reason why most European factories are more efficient than those of this country, both in production and the cost of operation, since the latter is seriously affected by the number of accidents occurring each year.

The lately organized conservation of vision movement has brought about an increase in the lighting facilities of many industrial plants, not al of which have given good results. Improper lighting is expensive to the employer as well as to the worker and hinders the highest efficiency of the factory. Workers in poorly lighted factories have usually some sort of visual defects caused by eye strain. They may also have anaemic tendency, or lowered physical condition. Workers in intense light suffer from dazzling and glare. The physical effects of these are fatigue, tears, inflammation, opthalmia, seeing red, and at times stone blindness and cataract. The highest efficiency can not be secured under either condition.

An artificial flower manufacturer in New York was induced by a factory inspector to supply a well-selected lighting sysfem in place of the scant daylight and few glaring lights under which his force of girls had been working for years. He was surprised to note an increase of twenty per cent in his output for the first month from the same force. The workers doing piece work were not only able to produce a larger quantity of flowers, thus earning higher wages, but the improvement in their quality brought a higher wholesale price to the manufacturer.

Most factory work is performed in daytime, by natural light. This is best for the yes, and the disinfecting properties of natural light have a beneficial effect upon the human system. In recognition of this, large manufacturers are moving their plants whenever possible to rural or suburban localities, where they can be surrounded with sufficient space to admit daylight ti their windows. Daylight is let in by windows either at the sides or on top of the building. A greater amount of light comes in from an opening on top, than from one on the side of the same size. Where space is not costly, cotton and other weaving factories are built one story high and have either skylights or the "saw tooth" roofs, which provide the most desirable lighting.

Most establishments depend upon the side windows for their daylight. The amount of light admitted in this way depends upon the heights of adjoining buildings; the color of the walls; the area of window space in comparison with floor space; the form of the room to be lighted, and the construction of the windows, including the kind of glass used. The effect of building in close proximity is so well recognized that laws in most cities require that any walls which intercept the daylight of another building shall be painted in some light shade.

The proportion of window space to the size of a room is beginning to be regulated by law, although much remains to be accomplished in this direction. The New York tenement law requires a window space to be from one-eighth to one-tenth of the superficial area of the room. Many of these tenements are used for manufacturing purposes. The insufficiency of this provision is evidenced by comparison with the German standard for factories, which requires a ratio of window space to room area of from one to five feet, or from one to three, according to the class of work to be performed.

The larger the panes of a window, the fewer columns between the panes: the higher in the wall and the nearer the colling, the greater amount of light it will supply. The kind of glass is important. Clear plate glass is best. More illumination is gained from ribbed glass because light rays are refracted in the uneven surface of the glass and instead of falling directly to the floor are directed horizontally into the room, thus illuminating a larger area than plain glass. Coloring of any kind lowers the lighting property. Window glass should be kept absolutely clean. A German inspector estimates that thirty per cent of lighting power is lost in glass covered with dust and seventy-two per cent through glass which is very dirty.

When the daylight is insufficient, or the factory is operated at night, artificial lighting is required. Artificial light has the advantage of being more easily regulated than daylight and thus is more uniform in its results. If properly regulated, it need not be trying to the eyes. The three artificial lighting mediums now used in industrial plants are acetilene gas, illuminating gas and electricity. Except for a few tenement workshops, no industrial plants are lighted now by kerosene lamps. Acetylene gas is made from calcum carbides, in special generators outside of the establishment. It is piped through the building like illuminating gas and is used in rural districts, where city gas and electricity are not obtainable. It produces a bright, clear light resembling daylight, and is generally regarded as being comparatively easy on the eyes. Illuminating gas is used satisfactorily in many large factories. Open flames are being rapidly discontinued as inefficient and dangerous. Incandescent matel burners in a variety of styles are replacing them for economic as well as hygienic reasons. The best matel burners produce a strong white light which needs to be shaded in some way.

Electricity is used in arc lamps, both of the flame carbon and the older enclosed types. Incandescent electric lights are used more frequently than either of these, as they produce less glare. The old form with carbon filaments is being replaced with the metal filament tungsten burners, which produce a high light intensity at about a third of the cost of the older style.

Certain industries make specific light requirements. The mercury vapor lamp which produces a blue green light is considered essential in sugar refineries to detect impurities in refined white sugar. It is claimed that this light is injurious to the eyes, and ocular inspection of the work in a large refinery recently revealed a number of cases of conjunctivitus. Hundreds of girls employed in film factories are compelled to work for hours in finishing films under a red light. A careful examination failed to indicate any injurious effect of the red light either upon their vision or their general health.

The question as to what constitutes adequate and proper lighting is not yet fully answered, as experts are continually experimenting upon the subject. Definite standards do not exist, and the present defective lighting systems are chiefly due to this lack of standardization. Illumination is usually measured by photometers and the unit of illumination is expressed by the term "candle foot.' This is defined as the direct illumination given by a standard candle one foot from the object to be illuminated. Roughly speaking, a foot candle represents the minimum illumination by which it is possible to read small print for a continuous period without fatigue. On cloudy days, the daylight indoors varies from 1 to 1.10 foot candles. On sunshiny days it ranges from 2.2 to 7 foot candles. In Germany, one foot candle is regarded as sufficient to read by, and from 1.5 to 5 foot candles are required for fine work in factories, while for specified industries, including embroidery, printing and knitting, an intensity of not less than 1 1-2 foot caidles must be supplied.

The lighting of an industrial plant must fulfill the two objects of providing the light for work, and protesting the worker and the public from accident. Several forms of lighting may be required for doing this properly. General lighting gives a uniform illumination throughout the room, but localized lighting throws special illumination upon the specific point. In a number of up-to-date clothing factories a small electric lamp, reflecting directly upon the point of the needle, is supplied to each sewing machine, in addition to the excellent general lighting system in the room. Miners suffer greatly from having to strain their eyes in order to see the points of their picks. In many cases, the old-fashioned miner's lamp could not be used on account of the fire risk. The Bureau of Mines is now making exhaustive tests for determining the safety of a portable edectric lamp for miners, which has lately been introduced.







**NOTICE OF ANNUAL MEETING.**

The annual meeting of the stcvkholders' of the Clarksburg Light & Heat Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the offices of the company the third Thursday in February, February 18th, at 9:30 a. m.

H. M. BROWN, Secretary.

In one of the mines of South Africa 190 horsepower is recovered by making use of the fall of water which is piped from a distance for various purposes in the mine.

New Zealand has an island nearly three miles in circumference, which is almost entirely composed of sulphur mixed with gypsum and a few other minerals.